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ABSTRACT

The Internet and the Information Super Highway have become familiar buzz words. This paper briefly discusses five projects with the general aim of using telecommunications and the Internet to foster the renewal of math and science education in rural schools. The broad questions, "Does access to the Internet and the Information Superhighway deliver the anticipated renewal of teaching and learning? If so, under what conditions? and to what degree?" are explored. The five projects are: (1) Teacher On-line Projects, (2) Creating Connections: Rural Teachers and the Internet, (3) Tennessee Valley Project, (4) Reach for the Sky, and (5) Rural Community Alliance for Enhancing Science and Math Education. In addition, detailed evaluation and/or description information for three of the projects (1, 3, and 4) are included. Data for the Reach for the Sky teachers was collected using questionnaires (n=19), interviews (n=22), comments online, a focus group discussion and classroom observations. Three themes were found: exhilarating experiences of having access to unlimited information and resources, overcoming of isolation and feeling part of a global community, and feelings of excitement and renewal. Data was collected for the Tennessee Valley Project through a questionnaire, a focus group discussion, electronic journals, comments online, troubleshooting sessions, interviews and observation of teachers and classrooms (n=14). Some of the triumphs and then some of the frustrations and barriers are discussed. Descriptions of the 10 projects in the Teacher On-line Projects report include gopher and world wide web addresses. (MKR)

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THE USE OF THE INTERNET BY MATH AND SCIENCE TEACHERS

A REPORT ON FIVE RURAL TELECOMMUNICATIONS PROJECTS

ED 384 509

A paper presented at the 1995 American Educational Research Association, San Francisco.

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The use of Internet by math and science teachers

John M. Rogan April 1995

Introduction

The Internet and The Information Super Highway have become familiar buzz words. In some circles, access to the resources of the Internet has become synonymous with educational reform. The purpose of this paper is to explore the broad questions, "Does such access deliver the anticipated renewal of teaching and learning? If so, under what conditions? and to what degree?"

In 1993, the Annenberg/CPB Math and Science Project funded five groups with the general aim of using telecommunications and the Internet to foster the renewal of math and science education in rural schools. The US West Foundation provided half the funding for the four Western projects. The five projects jointly represent one of the few initiatives to explicitly link reform in math and science education with the use of telecommunications. The extent to which these projects have succeeded in reaching this goal during the first year of operation will be explored in this paper.

The Projects

The five funded projects are described below.

a) Teacher On-line Projects

Teacher On-line Projects is designed to help rural elementary and secondary educators bring a new world to their classrooms through telecomputing. The ten sites include six from Minnesota, and one from Iowa, North Dakota, Michigan and Wisconsin; Teacher On-line Projects is designed to develop

on-line computer communication services to support the participating classrooms (teachers and students) in the application of problem-solving skills for community-based projects to improve their mathematics and science skills. From working with a local Wildlife refuge to develop to utilize this unique wildlife habitat as a means of economic development to partnering with a city council to identify success factors for maintaining retail business on main street. Each school community has established a team of one math teacher, one science teacher, and one community member, to implement a project that will use national mathematics and science standards to study a local community issue. As part of their participation each team will receive training and support as they guide their students in identifying a community issue and designing the solution to the issue.

Students will work as mathematicians and scientists using appropriate techniques and skills to resolve issues. Teams will communicate with other teams, share information, contact mathematics and science education experts, interact with researchers, and search for information through a variety of on-line resources through the Internet.

The five objects for Teacher on line Project are:

- Students, guided by their math and science teachers, will design a solution to an identified community problem.
- Students and teachers in the Teacher On-line Projects will access and share information with others through a variety of networks connected through Internet.
- Math and science teachers from rural communities will belong to a

"virtual community" with others working on similar projects to share experiences, teaching strategies, and project results.

- Students will work toward achieving selected goals of the math and science standards, identified with their teachers as they apply problem solving techniques to solve a community-based problem.
- Document and disseminate the process for providing access to appropriate resources and teaching strategies for rural math and science teachers.

b) Creating Connections: Rural Teachers and the Internet

Creating Connections is a project designed to provide an opportunity to rural teachers of math and science to learn to use the world-wide Internet network as both a professional development and a curricular tool.

This project enables teachers who are widely dispersed to participate in a program which offers on-going support following the initial workshop. This presentation will explore the effectiveness of the workshop for short term goals as well as the effectiveness of the on-going support via telecommunications to meet longer range goals. The paper contains a report on the activity of the teachers and their response to the availability of on-going support and the role which that support plays in the teachers' mastery of the tool.

c) Tennessee Valley Project

Designed to empower teachers of children in grades 4, 5, and 6 to improve

their science teaching by changing the way they teach science, partnering with practicing scientists, and tapping the information and communication resources of Internet, the Tennessee Valley Project will create collaborative research opportunities for teachers, practicing scientists, and higher education faculty on how best to implement strategies of reform through working partnerships.

Through the project, teachers will translate theories and strategies of reform in science education into classroom practice by synthesizing information and resources from six sources:

1. Science, Technology, Society (STS) techniques and strategies;
2. assessment techniques which reflect the new thinking about assessment;
3. state mandated curriculum guidelines;
4. National Science Education Standards currently being revised by the National Committee on Science Education Standards and Assessment;
5. Internet communication facilities and instructional resources;
6. partnerships with practicing scientists to create instructional activities modeled on the work of the scientist but designed for children in grades 4, 5, and 6.

d) Reach for the Sky

The goals of Reach for the Sky are:

* Providing teachers access to telecomputing equipment, sustainable connectivity, training, and technical support.
* Linking teachers to the Internet science/mathematics resources and data bases.

- Networking teachers with local, national, and global communities of peers and experts.
- Assisting teachers to create and conduct telecurricular units and to mentor other teachers in the development and implementation of similar units.
- Showcasing teacher innovations in the use of the Internet and telecomputing which provide role models of educational renewal.

During the first year of the project, 22 teachers of grades 3-12 with special interest in math and science, are receiving training in the use of the Internet and in the creation and use of telecurricular units. In the second year, these teachers will act as mentors for an additional 80 teachers who will receive all training online. After that it is expected that an unlimited number of teachers will be able to emulate the project model using the disseminated project materials with the assistance of online mentors.

e) Rural Community Alliance for Enhancing Science and Math Education

The primary goals of this project are to:

- Provide teachers and schools with the tools to integrate telecomputing resources into their science and math curriculum.
- Address issues of classroom reform.
- Gain the community support which is needed to provide funding for change.

In order to accomplish these goals trainers will utilize an interactive multi-media training package that will present models for using online telecomputing resources, leading to greater opportunities for problem solving and the development of critical thinking skills in math and science.

The Questions

Following the description of each project, representatives of the projects will form a panel and the questions below will be posed and discussed:

1. What happens when teachers who have never been on the Internet before are first given access? What are the frustrations and the triumphs? Are there one or more identifiable barriers to be overcome? Does the type of access make any difference?

2. What kind of math/science resources were found on the Internet? How easy was it to find and acquire these resources? Was the time spent perceived to be worthwhile? Which of the resources was perceived as being most useful?

3. Can the resources found on the Internet, or access to the Internet in general, result in better classroom practice? In which ways does access to the Internet change ways in which teachers teach and learners learn?

Methodology and Results

The methodology used by each of the five projects to collect data, and the results of the data collection will be presented in five separate sections. The North West Regional Educational Laboratories won the contract from Anneberg/CPB to be the external evaluator of the five projects. Some of the data presented were collected as part of the external evaluation. In addition, projects collected their own data, especially in areas that were unique to each project.

AERA Presentation April 1995

J.M.Rogan

Reach for the Sky

Methodology

The data presented in this section were collected using questionnaires, interviews, comments made online, a focus group discussion and classroom observations. During February 1995, a questionnaire devised by the external evaluator, Dr. Kim Yap of NWREL, was answered by 19 of the 22 Reach for the Sky teachers. In the same month, 13 of the teachers met in Helena, Montana, the State capitol, to participate in a technology fair at the Capitol building, and to meet as a project. During this time, all teachers met with the internal evaluator for a 15 minute interview. Teachers not attending the Helena meeting were subsequently interviewed by phone. Towards the end of February, the internal evaluator accompanied an external evaluator from NWREL on an onsite visit at two of the Reach for the Sky schools, Garfield School in Lewistown and the Winifred School, some forty miles north of Lewistown. During the visits, four classrooms were observed and an in depth interview was held with each of the four teachers. On the afternoon of 2/22, the external examiner facilitated a focus group discussion which included teachers (both part of the project and outside of it), administrators, students, parents, and community members.

Results

1. What happens when teachers who have never been on the Internet before are first given access? What are the frustrations and the triumphs? Are there one or more identifiable barriers to be overcome? Does the type of access make any difference?

Teachers in the Reach for the Sky Project spoke with feeling about both the frustrations and the triumphs of their experience with the Internet. One teacher put it, "The Internet is 45% frustration, 45% not being connected and 10% exhilaration." Some of the triumphs will be examined first, followed by the frustrations.

One overwhelming theme, which was repeated again and again, was the exhilarating experience of having access to unlimited information and resources. Some likened it to a large library to which they now had instant recourse, but the access is available without having to leave one's home. The access provided, for some, new avenues of learning and possibilities which previously had not even been imagined. The scope and variety of what is available proved to be a recurring sub-theme during the interviews. Some said that they enjoyed 'surfing the Internet' just for the fun is seeing what would turn up next. For others, just knowing it was there, made a psychological difference.

A second major theme to emerge from the responses of teachers was the overcoming of isolation and the feeling of being part of a global community. A phrase which reoccurred with some regularity was the enjoyment of "meeting new people". Specific contacts with peers, such as other middle school teachers, and with experts were mentioned. The latter category included seeking information from experts on diverse topics such as subways, the Loch Ness monster, adult education programs, dessert plants, and hantavirus pellets. Also mentioned as part of this theme was the opportunity to partake in some global telecommunications projects such as Live from the Antarctica, MayaQuest, Geogame and Where is Roger.

A third theme, which was diffused throughout most of the responses was one of excitement and renewal. The opportunities and possibilities were seen to be both exciting and overwhelming, but for all that much appreciated. The theme of "new approaches, new ideas, new resources" was a frequently reoccurring one.

On the other hand, the opportunities provided by access to the Internet were not without some frustration. As before, various themes emerged, shaped in part by the availability of resources at the school and the kind of access provided.

Time emerged as the number one source of frustration. Some mentioned the time that it took to master some of the skills needed to access the Internet. Almost all commented on how they wished there were more hours in a day to acquire resources and to use them. An important sub-theme to emerge at this point was the existing curriculum. Teachers are already trying to cope with a full curriculum. Invariably, time spent on some kind of telecurricular activity, even one linked to the existing curriculum, is going to take time from what was done before. Priorities will need to be decided. In the meantime, the pioneering teachers are trying to add new activities and skills to what is already in place. Often times, the resources obtained cannot be effectively used in the classroom without developing some kind of curriculum package to support their use. Again, this takes time. As fun as it is, the Internet can be a great waster of time. Some teachers spoke of hours spent trying to track down some resource because its location involved a lot of guess work. Others subscribed to a listserv, only to be overwhelmed by the volume of mail which suddenly arrived in their mail boxes. Time management and discipline became important skills to be learned. Teachers had to make time available on a weekly basis, usually at set times, and learn to neither skimp on or exceed what was

allocated. Some spoke of the adjustments they had to make in their lifestyles and family commitments.

Second, frustrations with the Internet itself emerged as a substantive theme. Basically, the Internet is not user-friendly and this was pointed out on a number of occasions. More specifically, the Internet is not reliable. If access is to be part of a lesson, there is no guarantee that a connection will be made. Frequently, access to a specific site is denied because it is heavily used. Other times, when access is gained, a particular resource is not available, or cannot be accessed. As one teacher put it, "There is so much to weed out." Teachers spoke of having to wade through messages on the listservs to glean out the small fraction of what was useful. Another source of frustration was experienced when 'experts' were approached and failed to answer or there was some other form of lack of response. Frustrations in this area were compounded by the lack of time. Some allocated a precious hour to find a particular resource and then came up empty handed. Either source of frustration by itself might have been acceptable, but together they became a major aggravation.

Third, Reach for the Sky has provided access to the Internet using a modem and long distance phone lines. This access mode does have its limitations. Some would have liked a graphic interface, with point and click capabilities. However, during the first year of the project, this was not feasible. This type of access also raised the question of cost. Those using long distance phone lines to access the Internet found that the cost of being online could be rather prohibitive. Many were shocked at their August and September phone bills! The offline reader, which is the main telecommunication mode advocated by the Project does keep phone costs low, but on the other hand does not permit browsing of the Internet. Many teachers

found themselves on the outside looking in when it came to direct resource acquisition. They had begun to glimpse what was out there for them to explore, but online costs limited what they could actually experience and download.

The fourth source of frustration is also cost related. As teachers began to realize the potential of the Internet and to experience learning modes hitherto unknown to them, they began to visualize new ways in which their students might begin to learn. However, in some cases these dreams floundered because of the reality of the classroom situation. In the worst cases, the classrooms were devoid of computers. Others did have a computer, but no modem or phone line. The gap between potential and actual learning in the classroom has become a source of frustration for a number of teachers. Some have been successful in getting their colleagues and administration to glimpse their vision and to start providing support in the form of hardware. Others have become more isolated from their colleagues, and are thinking of moving to technologically greener pastures.

2. What kind of math/science resources were found on the Internet? How easy was it to find and acquire these resources? Was the time spent perceived to be worthwhile? Which of the resources was perceived as being most useful?

Reach for the Sky teachers tended to fall into one of two groups. The one group consisted of teachers who had spent a lot of time searching the Internet for resources, and were by and large pleased with what they had found. The other group did not spend much time on searching for or accessing resources, but rather used the Internet to participate in telecurricular activities and thus spent time on

collecting, sharing and analyzing data. The two groups tended to be somewhat exclusive of each other, suggesting that time constraints forced teachers to set priorities.

Teachers who did invest time in searching the Internet for resources were pleased with what they had found, and felt that the investment was worthwhile. A list of resources cited is categorized and listed below. Numbers in parenthesis indicate how often a particular resource was cited. The complete data from the questionnaires is given in Appendix I.

Programs

Live From Antarctica - Math/Science/Social Studies
Interdisciplinary unit involving experts in the field and studying Antarctica.

Where is Roger? - Tracking Roger through the Eastern Hemisphere, we spent the last semester tracking him through Australia and have contacted other schools around the world who were also on the list. (2)

Geogame - A geography activity for Middle School kids. (2)

Mayaquest - Students being able to interact with experts online in Central America seeking answers as to why the Maya civilizations have disappeared. We are going to compare this ancient civilization to other ancient civilizations we've already studied in Europe. (2)

The Geometry Forum through which we get a Problem of the Week and a Project of the Month for the class or individuals to work on. The results are written and then returned to the forum. (2)

Graphics

Space related (8)
General or unspecified (6)

Lesson plans/Units

Math (5)
Science (3)
General or unspecified (2)

Information

Weather
Edupage News
Data for projects

Math (2)
General or unspecified (2)
Ednet
NIH
NWREL
CoSN

Software
Volcanoes

Listservs or general help
Ideas for the classroom (8)
Middle schools (2)
Math projects
Science/environmental projects (2)
Kidlink
General knowledge (3)

Other
Civil war letters
Shakespeare
Drama plays for elementary students
Santa
Firenet

3. Can the resources found on the Internet, or access to the Internet in general, result in better classroom practice? In which ways does access to the Internet change ways in which teachers teach and learners learn?

Ultimately, the worth of experimental projects like Reach for the Sky will need to be judged in terms of differences they make to the teaching and learning processes. Renewal in math and science education eventually needs to play out in the classroom if the project is to have any impact. Data gathered to date is based on self reported changes, gathered both by means of a questionnaire and an interview. Furthermore, four classrooms have been observed. Based on this data, Reach for the Sky teachers fall into two groups. The first and larger group reported some significant, in their estimation, changes to their teaching practice. The second group said that they recognized the potential for teaching differently, they were

proceeding with caution and were still learning themselves. This second group envisaged making some kind of change to their teaching in the near future. Both changes to the way in which teachers teach and students learn were reported in the interviews. The changes to teaching styles and methods will be dealt with first.

A major difference to the way in which lessons are taught appears to be the use of resources which were not available previously.

> "I have new ideas of how students can gain information and how to present it to other students."

Resources that were mentioned included images and textual information. While the former tended to be used as visual aids, and hence viewed by the students passively, the latter tended to be incorporated by the students in a more active manner in reports and discussions. The availability of these resources, in some instances, had a major impact on the content taught. For example, the availability of images from space led to a greater emphasis on this topic. Those teachers who were involved in telecollaborative activities during the Fall of 1994 reported on the data from other schools as an important resource. Finally programs such as Live from the Antarctica, Where is Roger?, and Geogame, where used, appeared to have made a major impact on classroom teaching.

A second major theme to emerge was that of personal growth, and more specifically the ability to overcome isolation and to incorporate more diversity in lessons taught. As one teacher put it,

> "I am more of a global person and very aware of what's going on in the rest of the world. I try to communicate that to my students so they realize what may be affecting their new found friends on different continents. We always

try to find commonalities on all parts of the globe. I am much more aware as a person."

Personal growth was a theme touched on by a number of those interviewed. Specifically, teachers were able to consult scientists and other teachers for ideas and advice. Perhaps more importantly, they were able to bring the outside world into their own classrooms. Some teachers allowed their students to follow the activities of scientists from all over the world working in the Antarctica, and to pose questions to them. Others had the opportunity to follow Roger across Australia. Science, geography, math, social studies and writing could all be incorporated into accounts of Roger's travels. One teacher capitalized on the fact that Roger declined to climb a rock sacred to the aboriginal people of Australia to initiate a discussion on sensitivity to cultural beliefs of others. Yet another way in which isolation was overcome was the provision of opportunities of students to communicate directly with other students in other parts of the country or world. In one school, each student was linked with a student teacher in a university methods course. This cross-age linkage proved to be exciting and beneficial to both groups. The university students discovered how much they had to learn about explaining math concepts using text only. Friendships were established that extended beyond the end of the course itself.

Third, some teachers reported that a major change was taking place in the way in which they taught. Lesson were becoming more student centered and less teacher directed.

"I have been able to personalize my teaching more to the individual student through the items that I have gained access to through the Internet. The students have been getting more hands on resources during this time."

Students were being given more freedom to pursue topics of their own interest, which were often sparked by some resource found on the Internet.

> "It has made me a much better teacher! I have more resources out there on the Internet. I have gained a better understanding of my students needs. They are directing their education more than they ever did in my class before. I feel that I have much better connections with other teachers from around the world. My students have gained more of a world view of things, understanding other cultures and breaking down stereotypes."

Another example is that in math classes, students were challenged to find ways of expressing the data that they had collected instead of the teacher telling them what to do. Some teachers reported that they were seeing their role more as that of a facilitator, and that their style of teaching was becoming more investigative and inquiry oriented.

> "Much more innovative and relevant to student needs for the future. More student centered and focused on investigative type activities."

Teachers also reported on differences in ways in which students were learning. In some cases these changes were well underway, while in others they were envisaged rather than implemented. One overall way of looking at the change in learning was summed up in the words of one teacher who quoted the old proverb,

> "Give me a fish and I eat for a day. Teach me to fish and I eat for a lifetime."

While learning in the past has tended to concentrate on assimilating a body of knowledge (usually set out in a textbook), the Internet encourages students to become seekers of knowledge and teachers the facilitators of learning in this new mode.

Looking now at some of the specific points made by teachers. One overwhelming response was that the use of computers and Internet access was proving to be highly motivational. For example, the ability to download an image from a source many miles away fascinated students. Many were excited both by the computer itself, and by some of the other indirect changes that were occurring as a result of the technology available.

> "The biggest change is new ideas in the classroom. The students are more interested even though they are learning the same concepts they would have learned from the book. It has a whole new flavor with different approaches that the students enjoy and think of as 'new'."

A second major theme to emerge was that students were becoming independent explorers and were taking more responsibility for their own learning. Teachers claimed that the problem solving skills of their students were improving. Specifically, the use of real data gathered by the students themselves, sometimes in collaboration with other schools, has made a big difference in attitude towards math and in how learning occurs. As students became more responsible for the analysis of their data, they sought to make meaning of what they had found, rather than to follow a set algorithm to come up with the right answer.

> "Because we are collaborating with other schools, the students have a REAL audience and REAL reasons for accuracy."

This theme was summed up by a teacher who said, "They will be doing more true science, not just the canned stuff."

Students were able to take charge of their own learning, to some extent, by the access to resources that were not previously available. In some cases these

resources were found and explored online. In other cases, they were available on CDs provided through the Microsoft partnership. Students were able to do independent research on topics of interest to them because of access to information previously unavailable to small, rural schools.

Third, greater collaboration between students was reported by some teachers. Many of the telecollaborative projects, as well as those found on place like the Geometry forum, required students to work in groups to come up with a solution to a problem. This solution would then be posted and viewed by students in other schools.

Students in some of the schools had direct access to e-mail, while others had to send message through the teacher. In either case, students were able to reach out to the world beyond themselves and their own community. To many of them, contact with other schools in Montana was as novel as being able to communicate with Estonian students.

Hence it would appear that students are becoming independent learners to some extent. However, a caution was sounded by one teacher. He reported that students are more inclined to explore and 'surf' than to specifically mine the resource for information to do with an identified research question.

APPENDIX I
List of resources as given in response to the questionnaire.

*Graphics on assorted planets from Nasa
*Some free software for volcanoes
*Teacher help on math science projects
*Lesson plans for Science
*Drama plays for elementary students
*Live From Antarctica - Math/Science/Social Studies

Interdisciplinary unit involving experts in the field and studying Antarctica.
*Where is Roger? - Tracking Roger through the Eastern Hemisphere, we spent the last semester tracking him through Australia and have contacted other schools around the world who were also on the list.
*Geogame - A terrific geography activity for Middle School kids. This has been really a challenge.
*Mayaquest - Students being able to interact with experts online in Central America seeking answers as to why the Maya civilizations have disappeared. We are going to compare this ancient civilization to other ancient civilizations we've already studied in Europe. This study has involved quite a bit of research on my part and the project has been extremely helpful in developing a bibliography and providing lesson plans and online resources.
*Projects with classes in other schools in which my classes could become involved.
*The Geometry Forum through which we get a Problem of the Week and a Project of the Month for the class or individuals to work on. The results are written and then returned to the forum.
*Listservs that offer ideas and lessons appropriate for my students Listservs that increase my general computer/internet knowledge *Lesson plans found while 'surfing'
*Images used for Science lessons
*Images of space objects.
*Projects from other teachers (Math),
*(Info. from a listserv helped me find) Civil Wars from an Iowan Soldier
*Images of many, many things of interest to my students
*I think that having contact with other teachers and exchanging lesson ideas to make things better for the students (more "real-world" and more hands-on and more future oriented) has been an invaluable resource.
*Lesson plans
*Pictures
*Personal contact with others.
*I have acquired access to math lesson plans on a variety of topics.
*Students were able to reach Santa on the Internet and receive a response.
*I have acquired the knowledge how to access whatever resource that I have a need for.
*I subscribed to listserves on Middle School issues and kidcafe.
*Graphics, and text with graphics
*Ideas from a list-serv for classroom projects
*Data for telecollaborative projects
*Space images
*Classroom lesson plan ideas
*Ongoing programs.
*I have used images from space.
*I have used information from other teachers in the project.
*I also belong to a firenet listserve.
*I use weather reports.
*I read teacher interaction on the internet.
*Material (Mean, Median, Mode)

*Satellite & telescope images.
*US Government Res.(NOAA, NASA, NIH)
*Images
*Where on the Globe Is Roger Project
*Geogame project
*Edupage news
*Math and Science lessons from a variety of sources.
*Scholastic Central: a great resource for materials, authors, science projects.
*Dartmouth Library: Shakespeare
*Environmental gophers: gopher.econonet.apc.org
*KidLink

AERA Presentation April 1995

Sue Goodwin

Tennessee Valley Project

Methodology

The data presented in this section was collected through a questionnaire, interviews, a focus group discussion, electronic journals, comments made online, and trouble-shooting sessions held at a meeting of all project teachers in February 1995. During the first week of February 1995, all teachers and the external evaluator participated in a one-day meeting held at The University of Tennessee at Chattanooga. Prior to that meeting, the external evaluator and the project director visited two participating schools, Michigan Avenue Elementary School in Bradley County and Decatur Elementary School in Meigs County. On these visits, the project director and external evaluator observed four classrooms and conducted extensive interviews with each of four teachers. On the evening of February 3, the external evaluator conducted a focus group discussion which included both participating and non-participating teachers, principals, parents, students, and one superintendent.

Results

1. What happens when teachers who have never been on the Internet before are first given access? What are the frustrations and the triumphs? Are there one or more identifiable barriers to be overcome? Does the type of access make any difference?

Tennessee Valley Project teachers have expressed both frustration and triumph in working with Internet. Ultimately, after initial difficulties with access

and using Internet navigational and research tools, most simply found it overwhelming. In the words of one teacher, "The possibilities just keep increasing. It's very overwhelming. It's most difficult to decide what to participate in and what not to do. It is all so exciting." This paper will look first at some of the triumphs and then at some of the frustrations and barriers.

Excitement and renewal is a constant theme. Teachers frequently commented on their own excitement in having new sources of information, particularly for rural schools, but even more at the effect of Internet access on their students' attitudes toward learning. "This is really a boost for a small, rural community school...great for the students...good for public relations, fantastic for parents...and boy, is teaching FUN again!." They found students to be much more actively involved in the learning both through more research projects and through various email projects such as keypals and correspondence with pre-service education majors at Universities.

The effect of Internet access on student learning and attitudes is also reflected by teachers throughout their journals. One social studies teacher commented on the difference between teaching her students about Germany before and after she had Internet access. When the students learned only from textbooks and encyclopedias it was, she said, "something you read about, not a real place." However, when they were able to correspond via email with kids who live there, "Germany was a real place with schools and houses and parents and pets." Students also viewed information gathered from Internet as somehow better than information gathered from books. When, for example, data about planets comes from the NASA Spacelink site, it seems much more relevant and reliable than

information found in textbooks, even though it may be no different.

Some of the student excitement and enthusiasm in the start up phase was generated by excitement about the technology. One sixth grade teacher reported that when she successfully sent an email message to a teacher down the hall and received a reply the entire class gave her a standing ovation. However, the other changes -- students using their own initiative in research projects, their enthusiasm for telecommunications related projects, the shift from passive to active learning -- are real and confirmed the teachers own excitement about the potential of telecommunications for their classrooms.

This enthusiasm was expressed in a number of ways. Having a totally new resource was as exciting to the teachers as it was to the students. One teacher equated teaching from the book with "teaching the same old stuff," whereas teaching with Internet was "challenging and exciting." Another teacher showed his enthusiasm by changing his plans to retire. "I am so excited about using this new technology I might work several more years. I would have retired after last year."

Another constant theme has been the effect of Internet access on the isolation of teachers and students in small, rural communities. "Until I started this project," said one teacher, "I did not know how wide open the world can be to a fourth grade teacher sitting in a very rural area of Tennessee. The Internet has opened up avenues to me and my students that I had thought to be impossible."

Teachers are ending their isolation through email. Working across the eight counties participating in this project, they exchange lesson plans, methods, and ideas.

They share resources they have found on Internet. They exchange information about local resources available for field trips or visits to classrooms. In some instances, beginning teachers and experienced teachers now close to retirement have formed mentoring relationships.

The isolation theme was addressed on another front: the feeling of rural school districts that they were alone in the problems they faced and that they did not have equal access to resources. One principal commented on the relief she felt when she realized that the other school districts were struggling with the same limited finances and resources that plagued her district. Another noted that their rural district was usually the last in line for the latest in technology and resources but that the telecommunications equipment and access to Internet had put them on the front line. One teacher's journal entry summed up this theme: "This has enabled students of our rural, low economic area to have the same resources as other areas. Students are excited about learning and realize there is an entire world out there that they were unaware of, but that they want to learn about and take an active part in."

There are, however, frustrations which, in some instances, become barriers. The greatest of these is the lack of time -- time to learn to use Internet tools and locate resources and time to develop new lesson plans and instructional activities. In fact, the teachers in the project can almost be divided into two groups, those who have computers at home and those who do not. Those with computers at home began to access Internet resources and use email to communicate much more quickly and with far greater ease than did those who did not have computers at home. These are elementary school teachers who are surrounded constantly by kids in their classrooms. Therefore, accessing Internet during the school day for research and

practice is extremely difficult One sixth grade teacher suggested to the project director that she "try this some time with 20 kids standing behind you, jostling to see what you are doing, and another 10 potential trouble makers drifting toward the rear of the classroom."

Time became a barrier in another sense when teachers who attended telecommunications training in July had to wait until late October for their computers, modems, and telephone lines. Several commented on the need for more training, particularly on-site training and training in small increments. This was, they said, a big change and they needed time to assimilate the information.

Others were frustrated by the difficulties of accessing the Internet, using more advanced Internet tools such as FTP, and especially the difficulties of uploading and downloading files using Kermit. These teachers have dial-up modem access to Internet and do not have access to the tools that simplify file transfer such as the Macintosh program, Fetch. What is more, many came to the project with little or no computer experience, so the difficulties they faced in mastering telecommunications were compounded by the difficulties they faced in becoming proficient computer users. In fact, many of the teachers in this project have learned to use their computers beginning with email and gopher.

In addition, teachers in three of the counties participating in this project face long distance charges to dial into the University Internet node. Long distance charges for research and instructional activities on Internet are prohibitive. The State provides an 800 number to teachers enrolled in the State program, but teachers who are not enrolled in that program (many remain on a waiting list) are simply

unable to take advantage of telecommunications without running up very costly telephone bills. Their access is therefore severely limited. In addition, there are currently questions being raised about the financial viability of the 800 access.

Finally, at the focus group meeting and in some teacher comments, one additional barrier emerged: state mandated achievement tests. Every year, Tennessee administers the TCAP (Tennessee Comprehensive Assessment Program) to all students. The State, school districts, and communities give great credence to TCAP scores, which are published in local newspapers by grade level, and the effect on teachers, particularly those in small rural communities, is profound. TCAP becomes a barrier to innovation when teachers perceive new methods as risky. One principal in the focus group session commented that teachers are not risk takers to begin with, and it is especially difficult in the culture of rural areas to take risks. Another observed that TCAP is a stranglehold on creativity.

2. What kind of math/science resources were found on the Internet? How easy was it to find and acquire these resources? Was the time spent perceived to be worthwhile? Which of the resources was perceived as being most useful?

Useful resources have fallen into two categories:
programs and projects designed for classroom participation and instructional resources such as lesson plans, graphics, or information, and human expertise.

Programs and projects
- Live from Antarctica
- Mayaquest
- Where is Roger
- The Math Forum
- Kidlink

Project Ididanet
Ask a Scientist on the Newton BBS
Geography projects such as Pizza Parties in which students solicit messages from around the world or geographical projects such as one in which students gather data on pets, mapping the other sites and gathering information
Penpal projects in which students correspond using email
One local mentoring project in which high school math students corresponded with third grade students in the same district

Lesson plans
Math
Science

Graphics
Images of Planets from Spacelink

Information
Data on planets
Weather Information
Answers to specific questions from AskERIC

Human Expertise
Scientists from ORNL (Oak Ridge National Laboratories)
Scientists from the Tennessee Aquarium
Other teachers

3. Can the resources found on the Internet, or access to the Internet in general result in better classroom practice? In what ways does access to Internet change ways in which teachers teach and learners learn.

At this point in the project it is difficult to identify definitively real changes in classroom practice. However, anecdotal evidence as well as evidence gathered on the survey conducted by the outside evaluator points to two changes: a shift from teacher-centered to student oriented lessons and a shift from instruction based on textbooks to instruction built around projects. Some of these changes are directly related to the Internet. Others are directly related to the new teaching methodology

to which teachers were introduced at the project 1994 Summer Conference, STS (Science, Technology and Society). Most, however, are related to a combination of the two.

STS is a student driven, inquiry-based model in which students identify problems, generate questions, identify resources, and so forth. Access to the Internet naturally becomes a tool in any project based on that model. Conversely, Internet access provides students with a highly motivating resource. Therefore, when teachers report more research activities they reflect both a shift in their classroom practices to more student-oriented projects and the accessibility Internet access gives to additional resources.

Teachers do report that they are changing their classroom practices to include more project based activities in which students raise and research their own projects. This has led to more classroom activities which function around learning centers (the computer and Internet access become one of several centers) and facilitating these changes has led to more teamwork among teachers. They report that students are beginning to use their own initiative in projects and to take responsibility for their learning. They are therefore much more actively involved in the learning. They report increased student enthusiasm, even to the point of extended hours at school. One school reported that students were coming 30 minutes before school to use the computer and staying 1-1/2 hours after."

Teachers also anticipate a growing role for Internet in their teaching. One team of fourth grade teachers commented that "Internet is an on-going experience. My teammate and I find new places every day. We discuss them and how we can use

them in our class. It will be amazing the change that will take place in our classroom by next year with the use of Internet. As we find new places, the Internet grows to meet the needs; there is so much there we have not even gotten started."

It would appear, therefore, that access to the Internet does change teaching and learning, but how and to what degree remains to be seen.

AERA Presentation April 1995

Joel Halvorson

Teacher On-line Projects

Progress Report on the Projects

To date, the ten teams have gathered for two Winter training Seminars, and one Summer Training Seminar. The first Seminar took place March 10-13, 1994, in Ely Minnesota. Here the groups were first introduced to the project and began their technical training. A key component of this Seminar was visits to the various community groups in and around Ely, which collectively support the study and research of Wolves. The Wolf Studies Project was designed as a "template" of a community based project, and has evolved into a popular resource for classrooms. (The Wolf Studies Project can be accessed via the World Wide Web (WWW) at http://InforMNs.k12.mn.us/wolf or via Gopher gopher://InforMNs.k12.mn.us:70/11/best-k12/wolf)

July 17-20, 1994 the teams gathered again in Marshall Minnesota, Where the Lynd, Minnesota team served as hosts. Here the projects used the computer lab facilities of Southwest State University, and began to learn how to remotely archive and disseminate their resources via the InforMNs (Internet for Minnesota Schools) server. (Team projects can be access via WWW at http://InforMNs.k12.mn.us/tops or via or via Gopher at gopher://InforMNs.k12.mn.us:70/11/mn-k12/tops). One highlight was the teams picnic at Camden State Park, where participants had a first hand look at the resources being used by the Lynd school community as part of their community project.

February 9-11, 1995 the teams gathered at TIES in Roseville, Minnesota, where much of the itinerary was dedicated to enhancing their technical skills. The itinerary was pre-determined via an e-mail survey. Of note was the interest in the development of WWW project home pages on the InforMNs servers. (The Seminar WWW pages are located at http://InforMNs.k12.mn.us/tops/winter95.html). Also, each team presented a status report of their project, and shared some of their highs and lows to date.

In addition, there have been numerous occasion where team members have attended additional workshops, presented at conferences or enhanced their local efforts through additional collaborations. There is regular ongoing support which happens on-line, with Joel, between the projects, or with others. The address TOPS@InforMNs.k12.mn.us is a group e-mail aliases which can be used to communicate with all members of the TOPS project. A large in-kind contribution to this project has been the technical resources and infrastructures of InforMNs.(Minnesota's K-12 Internet Access project for educators). As both Project director and a member of the InforMNs team, Joel has had the flexibility to use this resource and cater it to the needs of the project. With out such access to the InforMNs resources, the technical development and enhancement of the TOPS project would have been either too cost prohibitive or technically impossible.

Individual Projects status

Each of the ten TOPS sites initiated their local projects with their students beginning the Fall of 1995. Though this is a two year project, the full cycle is actually 2.5 years, completing the second years cycle June of

1996. Most of the first year of the project has been focused on preparing the ten sites to begin a two-year curriculum cycle which started Fall of 1994. The project has emphasized the need to let the local issue(s) with the students and community involvement, dictate the curriculum, content development, and the electronic dissemination via Gopher and/or World Wide Web. We have stressed that the Internet simply represents a conduit for learning, sharing, communicating and dissemination. The "local issues" themselves, are the primary focus of the projects. The hope is that once the students had a chance to become a "student of their local issue", the "what" and "how" of the projects would become more focused. By stressing the need to focus on the issue(s) during the start of the school year, we have anticipated a strong need for dissemination and content development throughout the winter and Spring of 1995.

Against this backdrop, the success of each of the ten sites runs the gamut. We have a few sites that are excited about the dissemination, and have teachers and students building World Wide Web resources; to projects which are still trying to focus on a local issue.

Below is a brief "spot check" of each of the ten sites:

Roseau Minnesota, Waste Management Project

The strongest component of this project is the unique partnership of Aidia and Larry MaCabe (McCabe@InforMNs.k12.mn.us), the husband and wife team which comprises the bulk of the communities 7-12 Math and Science Department. Both are veteran teachers and actively involved in their respective professional associations, the Sci/Math MN systemic reform initiative, and other unique projects such as Mayaquest and the GLOBE

project. In their situation "talking shop" at home has enhanced both their professional and private lives. Unfortunately this built in support is tough to mandate. However it does supports the need for teams with strong collegial relationships.

The Roseau project has 8th graders working with Jeff Pelowski, Roseau County environmental officer, to determine the cost benefits of reduction and recycling. They are also attempting to locate outlets for the economical disposal of recycled materials. Students are collecting data about the communities waste generated, and the environmental impact of past disposal techniques.

The Rothsay Minnesota, "Environmental Health of our Community" Project.

Rothsay is situated in an ecologically unique region of Minnesota. Within a 25 mile radius of Rothsay there are three ecological communities: prairie, wetlands and the transition community from prairie to forest. Using the natural resources, students are exploring the environmental health of their community by looking at; the diversity of the prairie/wetland plants and animals; the chemistry of the soils; and the water chemistry of our wetlands.

The Rothsay team is comprised of one very dedicated teacher, Mary Colson (Colson@InforMNs.k12.mn.us) and a less defined partner and community person. Rothsay is a unique school community and is of some national notoriety. In the 1980's, when the school was subject to close and/or consolidate, if took over the local hardware store. The store was put in the hands of the students, who managed to generate some revenue, while receiving on-the-job training. This idea was translated into the "Rothsay

community learning Center (CLC)", which has operated as a non-traditional school for area kids. Since the start of the TOPS project the CLC have taken a real financial hit, and the district was forced into consolidation with the neighboring district. Initially their participation in TOPS was in jeopardy, but through consultation with there school administrator, they have decided to use the TOPS project as a way to keep Mary full time. Mary is working with the science and math teachers to coordinate the project activities. With out this arrangement Mary would have been forced to commute part-time between the Rothsay district and a part time position in Moorhead MN.

The Rothsay district is in the process of connecting to the Internet using the existing cable network. This is a joint effort with their cable consortia and "Communicating for America", which is a for profit network provider. (Part of Communicating for Agriculture)

Blackduck Minnesota, Water Quality Project

The Blackduck team is comprised of Science teacher Harold Fenske (fenske@InforMNs.k12.mn.us), Math teacher Joe Sheppard, and community member Jim Barrott from the U.S. Forest Service. Harold has been the principle member of the team, and currently has his students monitoring three streams that flow into Blackduck lake, testing for temperature, dissolved oxygen, biochemical oxygen demand, nitrates, phosphates, turbidity, conductivity, PH, and fecal coliform. They are also sending samples to a commercial lab to test for herbicides and pesticides. They began early documenting, with text and images, their activities via their gopher on the InforMNs server. In addition to these activities, Harold is a

member of the Mississippi River Watch Project. This project has school sites using EPA equipment to take river readings which are eventually fed to the Minnesota Pollution Control Agency (MPCA). It was Harold, due to his involvement in TOPS, who has been coordinating the Mississippi River Watch Sites dissemination of river readings through the Internet. As a result Joel has been consulting with Steve Dittman of the Mississippi River Watch Project to further develop this project injunction with Harold and his other colleagues.

Clearbrook/Gonvick Minnesota, The Science of Wild Rice Production Project

The project team is comprised of math teacher Diane Moen (Moen@InforMNs.k12.mn.us), Science teacher Robyn Johnson, and county extension officer Doug Thompson (p01447@psilink.com). Clearbrook/Gonvick is in midst of the wild rice harvesting region of Minnesota. Here 5th and 6th graders are taking an in-depth look at the many aspects of paddy rice production. They have begun by providing their students with a first hand view of the various aspects of rice harvesting, and sharing these stages, with text and pictures, via their Gopher on the InforMNs server. In addition, both Robyn and Diane attended a workshop in November at TIES on how to build World Wide Web pages. Diane also presented a session during the recent TIES/MECC "Great Technology Get-Together" Conference in Mpls.

Lynd Minnesota, Camden River Valley Project

The Lynd team is comprised of teachers Kathleen Turgeon (Turgeon@InforMNs.k12.mn.us), Marlys Simpson, and Southwest State University Professor Linda Stevens (STEVENS@ssu.southwest.msus.edu). This group played host during our summer training institute last July held at

Southwest State University, which is seven miles from the community of Lynd. Lynd is a unique school district. It is an autonomous k-8 public school district of about 100 students. The community of Lynd sits adjacent to Camden State Park, on the Redwood river, in the Camden valley. This valley is a virtual oasis on the Prairie, and is in a deep valley with native hardwoods. The Camden valley has a long history of providing sanctuary for the Dakota Sioux, pioneers, and today's residents. An easy 15 minute hike out the back door of the school puts one in the heart of Camden state park. The park still show signs of severe erosion from the summer floods of 1993. To date the students have been investigating the various changes taking place in the Park, the plant and animal life, written poetry, and even composed original music. They, however have had many technical problems dealing with the Internet, and are at the point now where they will require additional support through their technical glitches. Fortunately they will be receiving some help from Education students from the University as well as from the staff at the Southwest ECSU (Educational Cooperative Service Unit) in Marshall.

Lynville-Sully Iowa, Community Sanitation System Project

Our lone Iowa group is comprised of math teacher Mark Watts (tops2@InforMNs.k12.mn.us), science teacher Launi Dane, media specialist June Gose, and local business leader Terry Van Ploeg. For there project they are examining the problems of their antiquated sewer system which was aggravated by the heavy rains of the summer of 1993. Their goal is to have the students recommend through their work a feasible, cost-effective method to solve the sanitary sewer problem. To date the students have been tabulating the data from a city council survey last spring and are

examining the land set aside by the city for a new treatment facility. They have also been gaining some Internet expertise and have made some presentations. Mark Watts has been the most active member, and has coordinated many of the local Internet training activities and presentations.

Southland Schools, Elkton Minnesota, Recreational Trail Project

The Southland team is comprised of math teacher Richard Hanson (Hanson@InforMNs.k12.mn.us), Science teacher Greg Staples, and community volunteer Mary Osmundson (0500do@InforMNs.k12.mn.us). The Southland project has been the first to make it's presence know on the Internet. This is almost exclusively due to Mary Osmundson commitment. Mary is a former South East ECSU employee, and due to health problems was forced to quit working. Her situation has created a full time technology volunteer and local project coordinator. Access to the Internet has allowed Mary to split her work between home and the school. She has also elicited the technical assistance of a recent College graduate to work with the local project, and has the kids already producing World Wide Web pages for dissemination on the InforMNs server (http://InforMNs.k12.mn.us/~0500sel). In addition she presented their project in a session at the recent TIES/MECC Great Technology Get Together in Minneapolis.

Mary has been able to focus on the technical aspects, thus freeing Greg and Richard to work on the project content with their students. To date the students have been study the flora and fauna along a railroad right-of-way which is being developed into a bike path. A portion of this right of way is through native prairie. They have begun documenting, with text and

pictures, their findings. They also intent to help plan and develop a recreational use plan for the bike path which could include designing and building a way-side rest and nature trail thorough the native prairie grassland.

West Iron County Schools, Michigan

Home of the Humungus Fungus, the worlds largest living organism, this team is comprised of Middle school principal Robert Peterson (tops4@InforMNs.k12.mn.us), Science teacher Bob Salonen, math teacher Sharon Holmes and community member Doug Curry. Their project has been loosely defined around the problems created by the sink holes which were left by the underground copper mine of the past century. They also have identified the declining economy, and their economic dependency on logging an tourism as issues. To date the students have been building Multimedia "products" of there investigations. They have been documenting the local history of the mines, communities, and the problems presented by the abandoned mines. As an example, they have extensively documented the events which led to the tragic death of a student in an old mine shaft. Students have begun to raise the issue of this ever present danger within the community. Their presentations are being incorporated into a local museum, and they are begging to translate their resources for dissemination via World Wide Web.

Doug Curry has been the primary contact person, and to his credit, has worked very hard to figure out some bizarre technical glitches which were preventing them from connecting to the Internet. Also, Robert Peterson who was originally the contact person had taken on a new administrative

assignment since the project began. They have also been involved in the GTE Great Lakes Governors project.

West Salem Wisconsin, Lake Neshonoc Project

The Wisconsin contingent is comprised of teachers Bill Jensen (tops3@InforMNs.k12.mn.us), Kathy Thompson, Media technology specialist Jan Wee (wsalem@uwlax.edu) and local environmentalist Barb Thompson. This group is principally involved because of the efforts of Jan Wee their Media director. She is a noted advocate of educational uses of the Internet. Over the past few years she has had her school involved in the International Arctic Project, the Greatlinks Governors project, Live from Antarctica, and The Russian Far East Project, to name a few. Jan has pushed to get as many of her teachers involved in Internet projects, and as a result, the district is in the process of connecting a 56KB line via the University of Wisconsin La Crosse, which is 15 miles away.

A few years ago, the local lake, Lake Neshonoc, was void of fish life and virtually dead due to agricultural run-off. With the assistance of the county and the state DNR, the school has helped resurrect the lake via fish stocking, and enforcement of various restrictions. As a compliment to this on-going effort, the school is focusing their TOPS project on the management and development of a tract of county owned lake shore for a recreational use park. The students are looking into methods which will preserve natural areas while also allowing for recreational use. The students have been studying the lake, its physical characteristics, regional wildlife, plant life, and the overall ecology of the watershed as they prepare to develop a plan for the park.

Upham, North Dakota Federal Wildlife Refuge Project

Our North Dakota contingency is comprised of, administrator Harlan Heinrich, (heinrich@sendit.nodak.edu), Math teacher, Kent Brown (tops1@InforMNs.k12.mn.us), Science teacher Bridgette Flaherty, and J.Clark Salyer Wildlife Biologists, Gary Erickson. Upham is the consummate rural community, with a district the size of Rhode Island, and a school population of 110+ students. Because of its size the entire math and science department, two teachers, have been committed to this project. The principle architect is Harlan, who wears multiple hats as the superintendent, principal, and computer science teacher. Harlan has skills unique to any small districts. He has been involved in computational science activities over the past several years, through use of the National Education Supercomputer, summer training institutes at NCSA (National Center for Supercomputer Applications), and annual participation in the educational strands of the Supercomputer Conference. For example during our summer training institute in Marshall last summer, Harlan had an opportunity to bring his math and science teacher to NCSA for a three week NSF funded computational science institute. Since this conflicted with our schedule, we arranged some activities concurrently through the Internet, and NCSA staff helped to cater some of their activities to match the training goals of our seminar. Harlan has been pushing to get a direct line into his school, and is using TOPS and the computational science activities, to justify such a connect. However, since the district is very small, and with out ample resources, the creative approach is required. I am hopeful that the school will be able to coordinate a connection with the administrative offices of the J.Clark Salyer refuge.

Since the refuge is only three miles away from the school, Harlan has been able to block out time for the math and science department to spend in the refuge when they need to. To date, the students have been working with the refuge biologists studying the various songbird species that inhabit the refuge. They intend to identify and map nesting locations and share this via the Internet and also with seasonal visitors. Also, the students have developed a survey that was distributed to visitors through the summer months of 1994. This survey was used to identify the types of services visitors would like to have available to them. The data from this survey will be compiled and processed by the math classes. This data will then be used to develop prospectus that will be used to determine if the services identified by the survey results could be an economical venture.

Conclusion

Not by design, all of the projects have selected local environmental issues. Environmental projects seem to fit well with middle school age students. Also, every community tends to have its share of environmental issues. It has been fascinating to watch these projects evolve from a kernel of an idea, to their present state. There our economies of scale which make this effort conducive to rural communities. The jury is still out on the replicability of this type of approach in larger suburban/urban settings. One of the most intriguing aspects of TOPS has been to observe the level of concern and ownership rise, once their efforts are "public to the world" via the Internet.